Assessment of possible incinerator application at Scott Base

Can thermal waste treatment an alternative option compare to the current waste management

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Table of content

1. Introduction

With the Antarctic Treaty implemented in 1959 human impact to Antarctica is partly regulated. Antarctica is our Earth last almost pristine continent. In the first years the main focus was laying on the fields of science and freedom, but environmental protection aspects came to an equal level of interest over time. Not least this fact is shown by the implementation of the additional conventions to the Treaty and the Madrid Protocol, which came into force in 1998 (Anon, 1998b). With Annex III to the Madrid Protocol of 'Waste Disposal and Waste Management' a major field of human impact is covered. Every human activity which includes use of resources in one way or the other creates waste, especially long-term activities. Science and presence of humans in Antarctica are therefore responsible for waste creation in the pristine ecosystem.

Annex III of the Madrid Protocol provides in general that waste must be removed from Antarctica and carried back to the home countries of the responsible parties to the Antarctic Treaty (Anon, 1998a). Further it is mentioned that waste disposal on land (landfill) or sea ice (when broke up waste is drifting away) is prohibited, as well as open fires to burn waste (Anon, 1998a). All those points are contributed to the protection of the ecosystem and to avoid harmful impacts of emissions.

The Protocol does not regulate the point what will happen with the waste when it is back in the home countries. Therefore waste can be treated in a way of best state of the arts from a waste management point of view (e.g. recycling, secured dumping…) or in one where there is a risk that the waste influences the ecosystems of the home countries. Best state of the art techniques in waste treatment and management are not applied in every country. The monetary factor is crucial in this case, because new techniques are often expensive in implementation and application. That is so although it reduces the possibilities of harmful impacts of the waste and hence that safes costs of negative results in the future.

At Scott Base the current waste management applies waste collection, separation and partly pre-treatment (e.g. glass, cardboard). The whole amount of waste (excluding waste water) is carried back to New Zealand by ship at one time per year. There, in Christchurch, the waste will partly further treated and leaded to recycling and landfill. Because of that waste management there are two risks to nature. Every weight what is carried to NZ needs fuel and creates emissions (e.g. CO_2), and because a certain amount of waste goes to landfill there are risks of pollution of ecosystems in NZ. Therefore it is advisable to assess the possibility of alternative waste treatments, directly at Scott Base. In the case of this assessment it will be investigated how an incinerator at Scott Base would change the situation. What are the advantages and disadvantages with a focus on the three sectors of economy, ecology and social aspects? It must be considered that there was a small time frame of just a couple of weeks. That limited the chance to get final information from industry, because it needs time to design the best adjusted facility.

2. Approach

Processes of incineration are improved to a level where benefits of the thermal treatment exceed harmful impacts to nature. In the last decade incinerators were developed to run with processes which treat waste to gain the energy content and usable compounds. At the same time flue gasses and ash are treated to create a minimum outcome, which is not further recyclable. Hence the advantage of incineration compare to landfill is that the waste is reduced to a much smaller amount and can dump without a big impact to the environment and a lower risk of impacts to it. Furthermore, because waste is a resource incineration gives the possibility to protect materials and reduce the need for exploitation. Compare to recycling incineration has the advantage that more waste groups can be efficiently treated. That considers the fact that waste is not every time homogeneous and often mixed and polluted with different material. The problem is that the different material cannot be separated efficiently. Thus such inhomogeneous waste is either not or just with expensive processes recyclable. The input energy and other resources to those processes are from an environmental point of view not justifiable, because the negative impact to nature is too big. Incineration can gain at least the included energy of the waste which protects the resources. Those facts indicate that different waste treatments must be considered for different cases of waste, if environmental protection is the overall goal. Carrying waste away from Antarctica can lead to shift the problem instead to solve it.

Waste management in Antarctica itself is at several points limited. Indeed the collection and separation of waste are not influenced, because the needed facilities and organization structure as well as the education of staff and visitors can be applied sufficiently and efficiently (e.g. waste management of Antarctica New Zealand). However treatment needs special infrastructure which is limited. Consideration of recycling of certain material like glass or paper needs special factories. Those kinds of facilities are just cost-effective and meaningful in greater settlements, respectively with a larger amount of material. Because landfill is prohibited and would harm the ecosystem (even the best state of the art technique would be applied in Antarctica) incineration respectively thermal treatment of waste is an alternative to treat the waste at the continent.

Incineration is applied in Antarctica since several decades at different stations. At Scott Base there was an incinerator installed. Currently incinerators are in service at an Italian and the Australian stations, at least. A major problem with burning waste is the creation of flue gasses which includes different harmful emissions, depend on the burned waste. If those flue gasses are not treated after the burning the included emissions can pollute the Antarctic ecosystem in an irreversible way. We will come back to that point. Prior that it must be considered to think about that incineration provides some advantages up to that point. The amount of waste is reduced and it is not necessary to carry it back, that amount of weight. Hence fuel for transport is saved and therefore costs too. Furthermore if energy is recovered from the process it reduces the production of it with other processes (e.g. burning of oil). Modern technology provides nowadays the possibility to treat the flue gasses to such a level that it is not harmful for nature or humans. E.g. in Germany and Austria incinerators are in service close to human settlements and even in cities. Those facilities are designed to treat huge amounts of waste compare to the emergence at Antarctic stations. However, there are incinerators at the market which are designed for small waste amounts and are working with similar results.

The special situation of an Antarctic station (small population, small amount of waste, surrounded by a sensible ecosystem) makes it necessary to consider similar cases of waste management / -treatment, rather than ones of big settlements (dense populated regions and cities). Cruise ships are operating under such similar conditions. Small cruise ships have a capacity of around 300-500 people on board (passenger and crew) and must be meet the MARPOL Convention (International Convention for the Prevention of Pollution from Ships). MARPOL Convention prohibits any dispose of plastic and regulates the dispose of other garbage to the sea (Anon, n.d.-c). Waste must be disposed on land or treated onboard. Due to that fact cruise ships (especially new buildings) are equipped with modern / state of the art waste treatment facilities. Thereby incinerators are a crucial part, because space on board of a cruise ship is very limited and there is hardly any storage capacity. Because of that Antarctic stations can be compared with cruise ships in our case.

The first contact to reach that point was with the ship yard company Meyer Werft GmbH & Co. KG (one of the biggest cruise ship yards in the world). From there two contacts of component suppliers for waste treatment systems were provided: Deerberg System (Oldenburg, Germany) and Scanship AS (Lysaker, Norway). Both companies equipped more than two hundred cruise ships with their facilities (Anon, n.d.-b, n.d.-d). The contact to those experts was necessary to get qualified information about the possibilities for Scott Base. Waste management must consider every time the conditions of the specific case. Therefore it is hardly possible and not sufficient to make general assessments. Waste contents of different groups with different amounts and every system provides a different frame for it. That means for Scott Base that is important to know what kind of waste is created, what can be burned and what must be considered to install an incinerator. As an example could be mention that a certain material in the waste needs a pre-treatment process before it can be treated by an incinerator (food waste, due to the high content of moisture). Depends on the different processes just the supplier is able to design the best treatment facility. Nevertheless the results should be assessed by an independent expert.

The waste data from Antarctica New Zealand of the last four seasons were considered to provide Deerberg and Scanship sufficient data and information. Those data were separated by waste groups of burnable and non-burnable waste and computed with a calculation program to get an overview about the total, average and partial values. The results for Scott Base are shown in Annex I. Figure 1 and figure 2 shown the order of flammable waste groups. Those results were reported to Deerberg and Scanship. After a first feedback from Deerberg including the need for more detailed information about the waste groups content and waste management at Scott Base those additional information were reported to both companies too (figure 3). The questions were answered directly by Scott Base staff of the current season via e-mail and after guided tours by those at Scott Base.

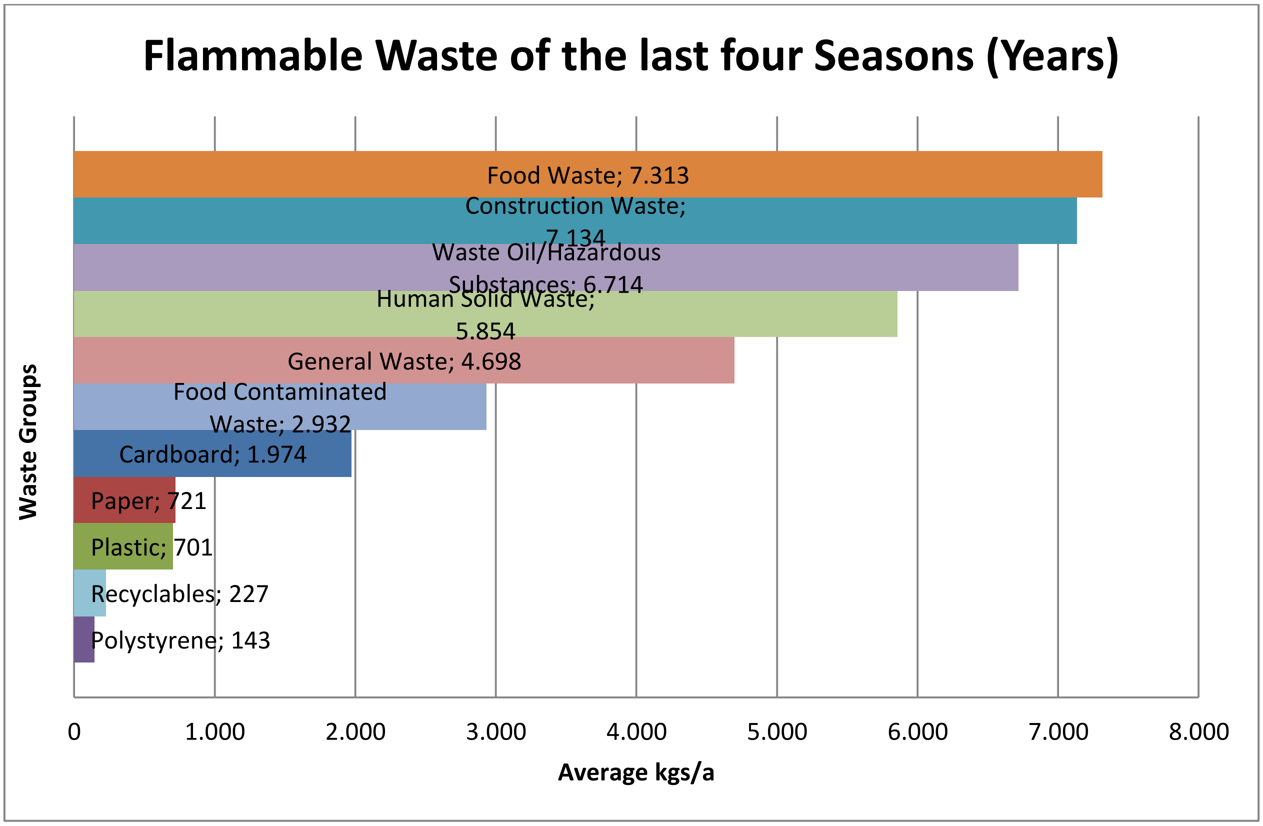

Figure 1: Flammable Waste of the last four Seasons of Scott Base in kgs/a

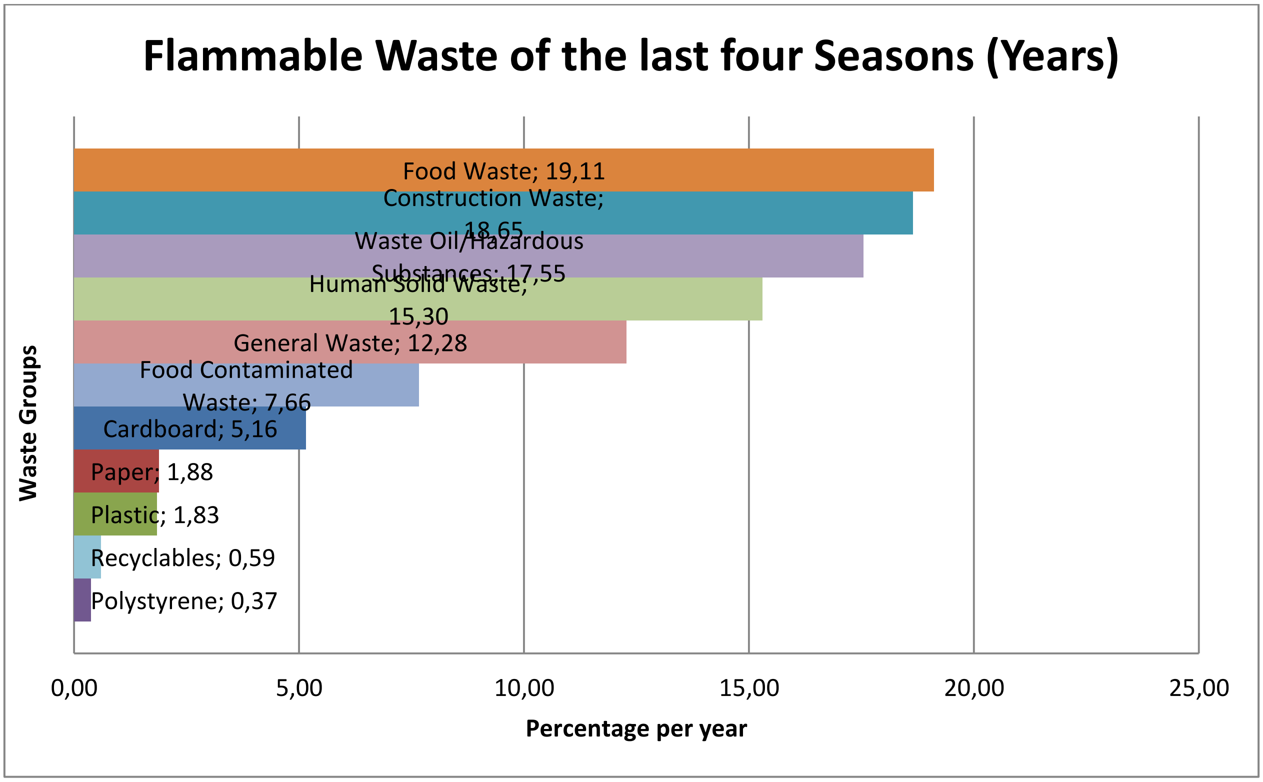

Figure 2: Flammable Waste of the last four Season of Scott Base in percentage per year

- What is the 'Dry Solid Content' of the waste groups 'Food Waste', ' Food Contaminated' and 'Human Solid Waste'?
Answer: This is best guess as we don't dry these:

Food waste – 25%
Food contaminated – 95%
Human solid waste – 40%

- Is 'Human Solid Waste' the sludge of the waste water treatment plant? Is there a decanter used for?
Answer: 'Human Solid Waste' consits of gathered feces of the field camps (plus paper; enclosed in two plastic bags) and sludge of the waste water treatment plant. Dry Solid Content: feces (???), sludge (around 90%). For the waste water treatment plant is no decanter in use. The water is droping out of the sludge.

- What is the texture of 'Waste Oil? Is that flammable? What is the fuel value?
Answer: Texture is just standard waste oil. Yes it is flammable but the fuel value is not known. The majority of oil we use here is Delvac ESP 5W-40.

Unfortunately we/I can't say what the fuel value is. I found that: http://www.mobil.com/USA-English/Lubes /PDS/NAXXENCVLMOMobil_Delvac_1_ESP_5W-40.aspx

I hope you can make suggestions if similar products of the market.

- What is the content of the 'Hazardous Substances'? Can that be burned without any problems, respectively is it allowed?
Answer: It is allowed to burn those substances, as long the facility works in the maximum state of the art (minimum of emissions).

- Is there already a up to date waste water treatment plant?
Answer: The treatment plant is around 15 years old.

Figure 3: Answered question of the first feedback from Deerberg Systems

After the first contacts with further experts of waste management and waste treatment it was clear that the amount of waste at Scott Base could be too small to have a profitable result if the current waste management will be changed and an incinerator will be used (Lindenau, 2014; Scheffold, 2014). With other words the costs to install an incinerator facility would not cover the saved costs for the reduced fuel consumption if the waste is not carried back to NZ. Due to this reason a second step was considered in the assessment. This includes the fact that Scott Base and the American station McMurdo shares such a facility. The advantage is that McMurdo station is much bigger and hence produces multiple times more waste. In turn the reduction of carried waste would be higher, the saved fuel costs too and therefore the facility could works profitable after certain years. The data and information of USAP were collected and computed (United States Antarctica Program) in the same way like the ones of Antarctica New Zealand. To reduce the workload for the first query for Deerberg and Scanship (because their help and information would not be charged) those data should just inquire after the results of scenario 1 (Scott Base alone). Scenario 2 is therefore the waste of McMurdo Station and scenario 3 covers the shared facility of both stations. Annex II shows the minimum burnable waste of McMurdo Station. Additional amounts of the other groups are missing, due to the fact that the percentage of burnable waste was unclear until that point. It was tried to get answers for the questions of the Scott Base waste groups, but adjusted to the McMurdo case. In the meanwhile the answers are there, but without assumed numbers. Thus own assumptions were made. Figure 4 and figure 5 shown the order of flammable waste groups of McMurdo Station.

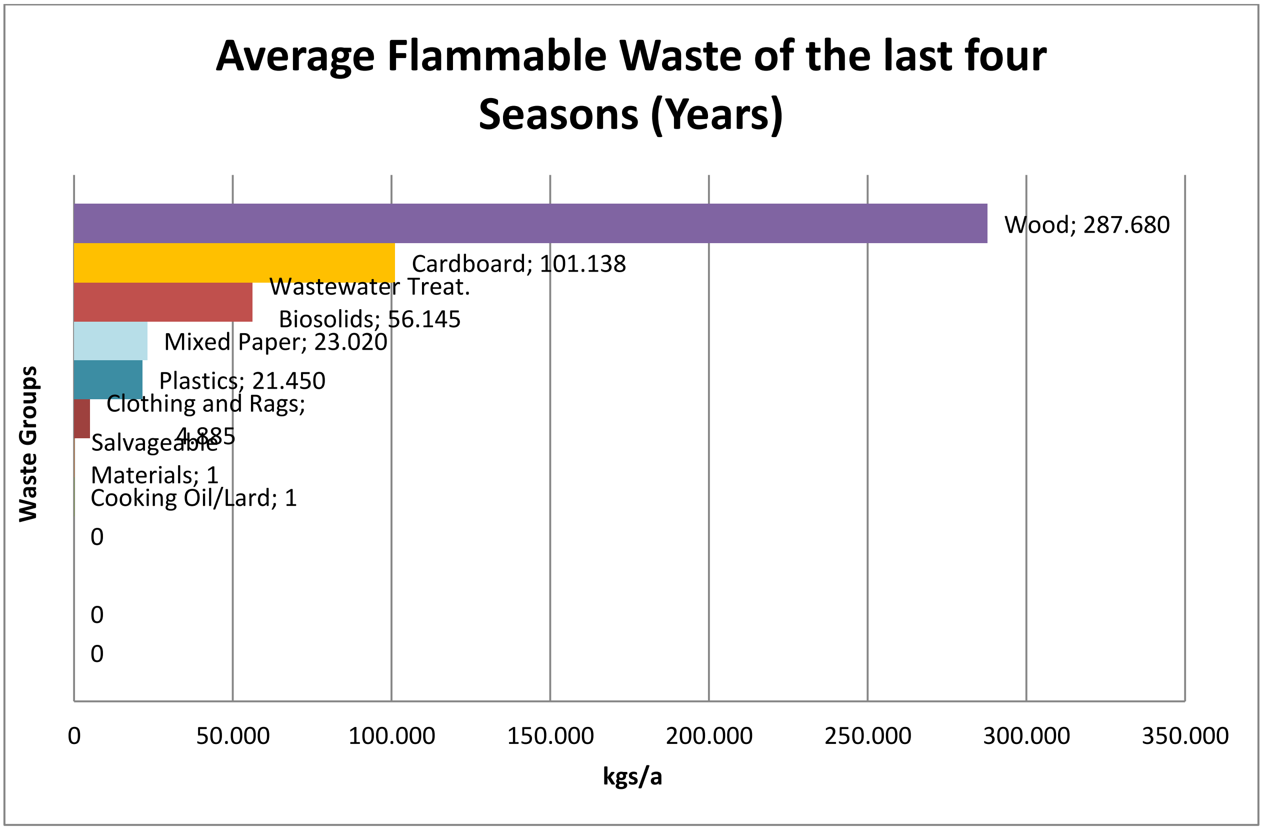

Figure 4: Average Flammable Waste of the last four Seasons from McMurdo Station in kgs/a

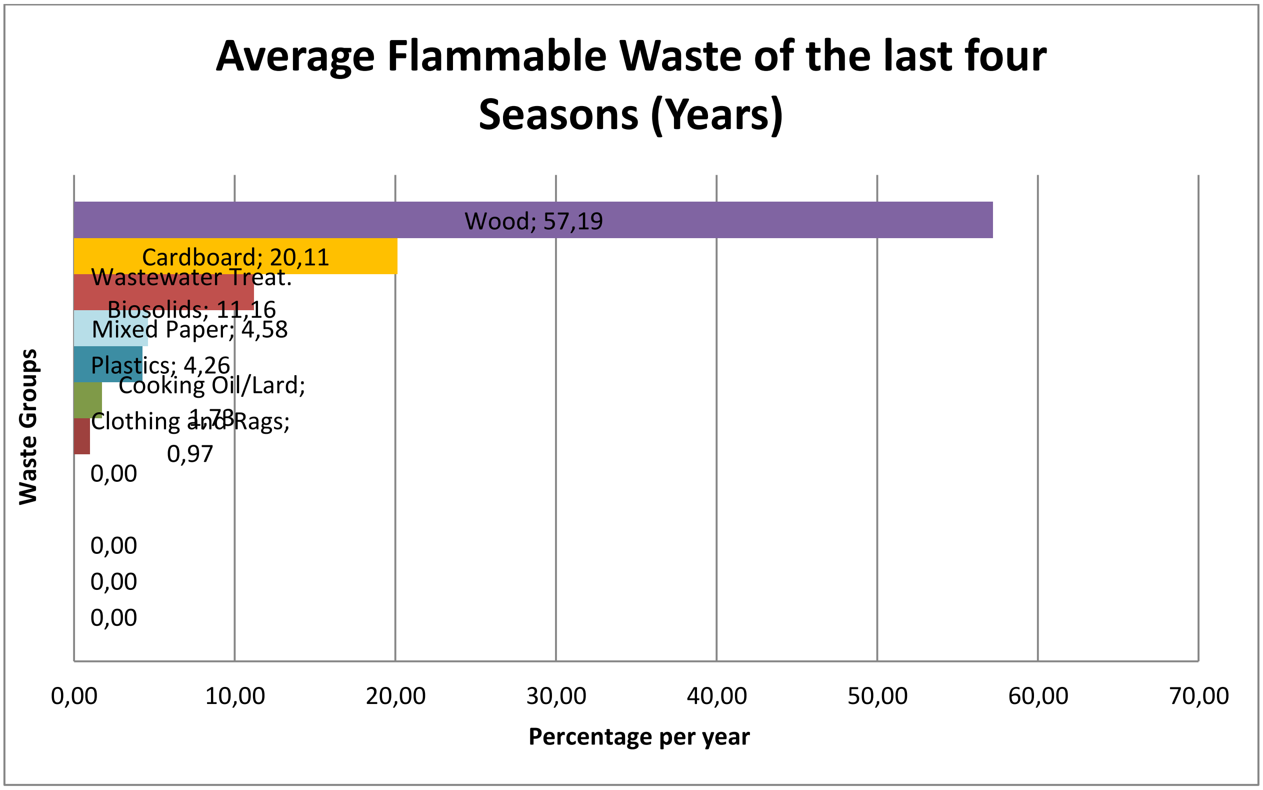

Figure 5: Average Flammable Waste of the last four Seasons from McMurdo Station in percentage per year

Summary of burnable waste of all three scenarios		
Scenario	min Waste kgs	max. approx. Waste kgs
1 (SB)	18.160	38.262
2 (MCM)	503.008	1.053.000
3 (total)	**521.168**	**1.091.262**

Figure 6: Scenario 3 - Computed and assumed burnable waste of Scott Base and McMurdo Station

In figure 6 is shown the total amounts of burnable waste for all three scenarios. The minimum waste (blue column) is computed from the available information and data. In the green column we can see the maximum waste which could be burned (approximated) if it is possible to include waste which needs either pre-treatment (drying) or a special process of thermal treatment (this material must be burned with specific temperature or the flue gasses must be treated in a special way to avoid the creation of harmful substances like dioxin). Plasma gasification could provide a possibility for such a scenario. We will come back later to that point.

In a final step it should be considered how much waste could be burned with an efficient process and how much fuel could be saved due to this. Furthermore the reduction of environmental pollution should be considered. That includes reduction of CO_2-emissions (<burned marine diesel) and risks of pollution from landfill leakage (<waste to landfill). To reach that goal fuel savings and tCO_2e were computed by Antarctica New Zealand and Enviro Mark Solution. Additionally specific papers where landfill leakages are considered were investigated.

3. Results and Assessment

3.1. Emission Reduction

Enviro Mark Solution computed some data of tCO_2e and it was possible to assume fuel savings in liter of marine diesel by Antarctica New Zealand. Those data are not sufficient enough to make any calculations how big the reduction will be on emissions or the savings of costs. For such a calculation more time is needed because a lot of information are currently unknown (e.g. what is the price of one liter marine diesel; will the costs for the used cargo shipped be reduced if less marine diesel is used; how can we calculate an average saving per kgs of waste…).

The investigated papers indicate that incineration is from an environmental point of view better than disposal of waste to landfill. That is the fact because the waste is treated and the risks for leakage to the ecosystems (soil, groundwater, air) over hundreds and thousands of years are minimized. Just the ash must be dumped. If energy is recovered from the thermal treatment in the incinerator the results are even better. (Cherubini, Bargigli, & Ulgiati, 2008; Marchettini, Ridolfi, & Rustici, 2006; Powell & Brisson, n.d.; Rabl, Spadaro, & Zoughaib, 2008)

In general there is a reduction of fuel, because less weight is transported and hence less CO_2 will be emitted. Also the waste disposed to landfill is decreased and therefore the risks. A specific assessment is currently impossible because further information about cost of fuel are currently not available. Furthermore the assessment paper about landfill and other treatment / dispose options do not consider the special facility where the waste from Scott Base is disposed (Kate Valley landfill). Therefore it is unknown if Kate Valley is at the same technical level designed as those landfills assessed in the papers, and hence the risks of possible leakage are not assessable. Further investigation at Kate Valley landfill is needed to consider the risks of landfill to the New Zealand ecosystems.

3.2. Deerberg Systems

Deerberg Systems provides for scenario 1 an incinerator system which is based on the principles of incineration and storage. It includes a 100 kW incinerator and allows to burn 20kgs waste per hour. Deerberg just considered waste where a need to run the incinerator 1.5h per day is and excluded the groups of ‘Food Waste’ (pre-drying needs too much energy), ‘Human Solid Waste’ (pre-drying needs too much energy), ‘Construction Waste’ (need of special burn process to avoid harmful emissions) and ‘Waste Oil/Hazardous Substances’ (need of special burn process to avoid harmful emissions). The waste will be burned in the process of 100%, flue gasses will be post burned to avoid and reduce harmful emissions and the material will be reduced to ash of an amount of 5% total. (Anon, 2015; Kirsch, 2015a)

Energy is not recovered because this is inefficient with that small amount of waste (Kirsch, 2015c).

Mr. Kirsch mentioned further concern about qualified staff at Scott Base. That point could be handled by Antarctica New Zealand if there is a lack.

‘Construction Waste’ can definitely be burned, because there is almost no hazardous material included (mostly wood). That increases the amount of burnable waste up to 18 tons per years. The facility should be changed for that purpose just at the storage capacity. The incinerator can treat more waste as currently considered (20 kg/h multiplied by 24 h multiplied by 365 days divided by 1000 = 175.2 tons per year) which provides the option to increase the amount without the need for a bigger incinerator. (Kirsch, 2015c)

The price for the suggested system is around 580.000 - 630.000 € including the transport of the equipment from Germany to New Zealand and the commissioning works. Not included are

- transport of the equipment from New Zealand to Scott Base (unknown)
- travel costs for the commissioning engineers from New Zealand to Scott Base (unknown)
- installation of the equipment

(Kirsch, 2015b)

Deerberg provides additionally solution for pre-treatment of non-burnable material, which is covered in the data table. That includes compacting of metal and crushing of glass. (Kirsch, 2015a)

In Annex III a 3D-picture shows the arrangement of the facility. The technical specification from Deerberg, including every detail with description of the process is attached as a separate pdf-file.

Scenario 2 and 3 is inquired. Unfortunately there was not enough time so far to design those ones.

Deerberg provides a detailed and well descripted technical specification. The suggested treatment system and incinerator considers the specific case of Scott Base and provides the possibility to treat unproblematic waste groups which covers almost 50% of the total waste amount. Additional treatment is not practicable in an efficient way, because additional treatment processes are needed which are not justifiable from an economy point of view. That is mainly related to the small amount of waste.

With the provided information by Deerberg further planning is possible to consider installation and integration at Scott Base and to its systems.

3.3. Scanship AS

Scanship provided a solution with its smallest incinerator. This incinerator has a thermal capacity of 600 kW (Annex IV) (Anon, 2010). Further details to assess the treatment process are not mentioned or explained. The considered amount of burnable waste of Scott Base is furthermore hardly reproducible. 90-100 kg/d (Wien, 2015) considers the calculated average burnable waste (104.83 kg/day), but it is unknown why there is a range taken and this does not cover the right amount. Any detailed explanation is missed (Wien, 2015).

An additional suggestion is the hint to the food waste digester. This facility produces nutrient rich water and needs probably less energy (Wien, 2014). The information provided by the small catalog of the digester let assume that could be an efficient option to treat food waste at Scott Base. A more detailed assessment is not possible, but advised for further investigation to improve waste treatment at Scott Base.

In general the information provided by Scanship AS are very insufficient. The missed providing of any costs of the systems does not allow any assessment compare to the current waste management. Furthermore it cannot assess for future planning how the system could be integrated to Scott Base systems and how the process works in detail. It is unknown how ‘good’ and environmental friendly the system works. Therefore it cannot assess if the applied technology is state of the art should be considered for further planning from an environmental point of view.

With the provided information by Scanship further planning is impossible.

4. Final Assessment and Next Steps

The collected information (especially from Deerberg Systems) shows that thermal waste treatment at Scott Base can reduce environmental pollution. However, from an economic point of view it is not profitable to install such a facility, due to the small amount of waste. Would that amount increased multiple times the costs would be recovered and energy recovery from the incinerator could be applied too in a profitable way (Kirsch, 2015c). Until now it is also unlikely that if environmental protection and social aspect are considered the installation of an incinerator at Scott Base is meaningful. Besides money it needs a certain amount of resources to realize that project. Indeed there are no information known to assess that case, but it is unlikely that the spend resources will compensate the saved ones.

At the moment there are strong evidences that an incinerator for scenario 2 and 3 would reach a profitable outcome at an economic level and would make sense from an environmental and social aspects point of view. The minimum treated waste of Scott Base and McMurdo Station would be almost 30 times higher as for Scott Bas alone. Therefore it is likely possible to run the incinerator 24-7 and recover the energy. That would provide additional savings of fuel. To assess that it is necessary to get information and suggestions for facilities for that scenario, as well as any for the costs. Because of those facts it is suggested to investigate scenario 3 – a shared thermal treatment facility of Scott Base and McMurdo Station – more in detail.

For every scenario it is crucial to investigate the saved costs of the reduction transported cargo, disposed and treated waste and reduced emissions. This is important for all three sectors.

Thermal treatment of waste is not only possible by incineration. Plasma gasification is another process. This provides the possibility to treat the waste without flue gasses, what reduces emissions to air to a minimum (Kaldas et al., 2006). Furthermore the state of the art process could provide the possibility to treat much more waste groups without harmful impacts to the environment (Anon, n.d.-e) and a higher profit due to saving of more costs (Anon, n.d.-a), even such a system could be quite expensive (Good, Antaya, Chapman, Morehouse, & Taylor-Roth, n.d.). This option indicate that if there is a serious interest to investigate the possibility to change waste management at Scott Base (Ross Island), to provide benefits for the economy, ecology and social sector, other treatment options which are state of the art should be considered.

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Annex

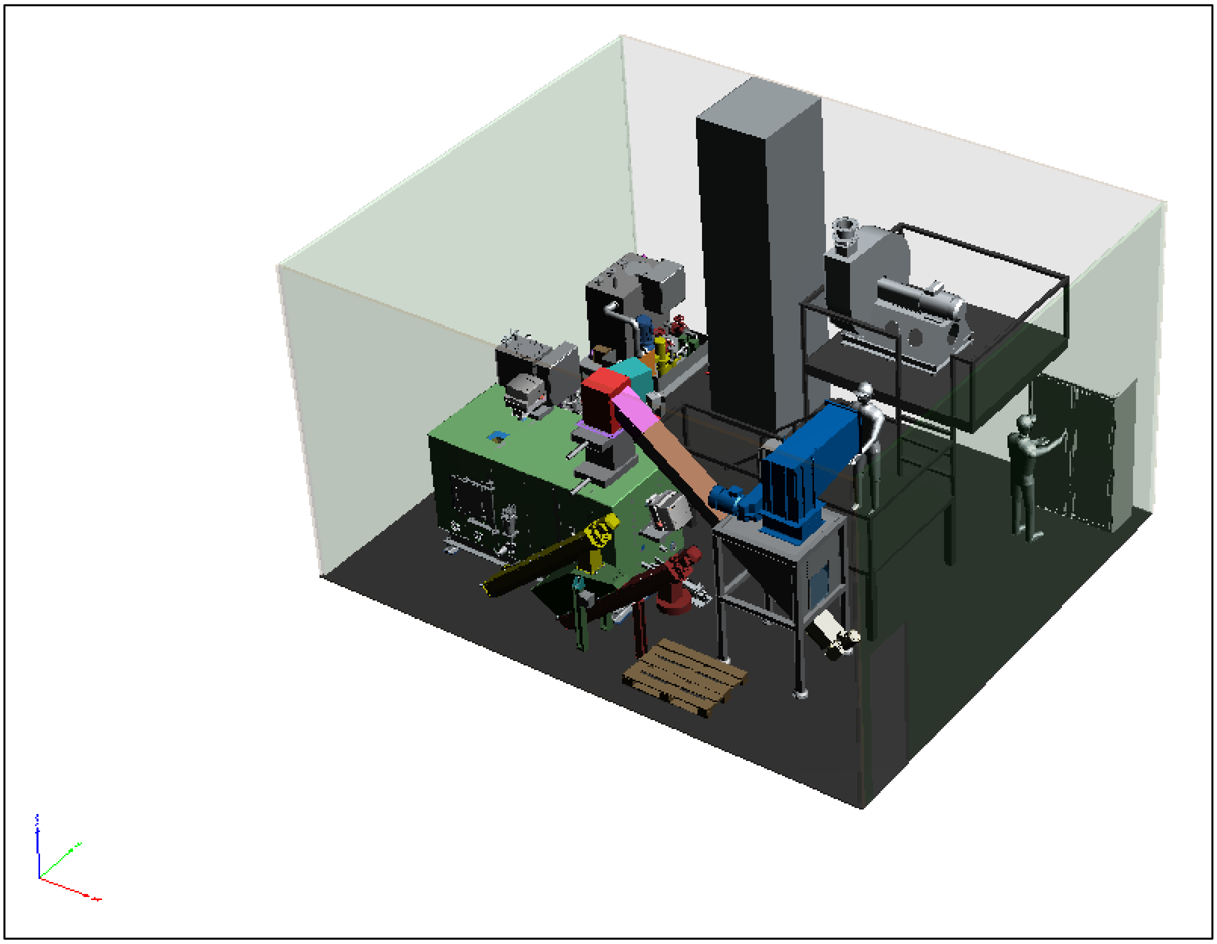
Annex I: Computed waste data of Scott Base

Flammable Waste of the last four Seasons (years)	2009/10			2010/11			2011/12			2012/13			Average				Percentage	
	lbs	kgs	kgs/d	lbs	kgs	kgs/d	lbs	kgs	kgs/d	lbs	kgs	kgs/d	lbs	kgs	kgs/d	gs/capita/	gs of grou	kgs of tota
Cardboard	6.739	3.063	8,39	4.297	1.953	5,35	1.000	455	1,25	5.332	2.424	6,64	4.342	1.974	5,41	0,15	5,16	4,58
Paper	3.747	1.703	4,67	740	336	0,92	1.000	455	1,25	858	390	1,07	1.586	721	1,98	0,06	1,88	1,67
Plastic	1.241	564	1,55	1.073	488	1,34	1.800	818	2,24	2.057	935	2,56	1.543	701	1,92	0,05	1,83	1,63
Polystyrene	511	232	0,64	433	197	0,54			0,00	0	0	0,00	315	143	0,39	0,01	0,37	0,33
Construction Waste	11.400	5.182	14,20	24.480	11.127	30,49	5.501	2.500	6,85	21.400	9.727	26,65	15.695	7.134	19,55	0,56	18,65	16,57
Food Waste	14.705	6.684	18,31	14.053	6.388	17,50	17.710	8.050	22,05	17.889	8.131	22,28	16.089	7.313	20,04	0,57	19,11	16,99
Food Contaminated Waste	10.840	4.927	13,50	7.057	3.208	8,79	5.346	2.430	6,66	2.561	1.164	3,19	6.451	2.932	8,03	0,23	7,66	6,81
General Waste	15.218	6.917	18,95	7.596	3.453	9,46	12.191	5.541	15,18	6.334	2.879	7,89	10.335	4.698	12,87	0,37	12,28	10,91
Human Solid Waste	19.085	8.675	23,77	6.000	2.727	7,47	14.840	6.745	18,48	11.589	5.268	14,43	12.879	5.854	16,04	0,46	15,30	13,60
Waste Oil/Hazardous Subst	18.196	8.271	22,66	18.113	8.233	22,56	11.697	5.317	14,57	11.080	5.036	13,80	14.772	6.714	18,40	0,53	17,55	15,60
Recyclables	1.000	455	1,25			0,00			0,00	0	0	0,00	500	227	0,62	0,02	0,59	0,53
Total	102.683	46.674	128	83.842	38.110	104	71.085	32.311	89	79.099	35.954	99	84.177	38.262	104,83	3,00	100	89,22
Nonflammable and Recycable Waste of the last four Seasons (years)																		
Aluminium Cans	1.554	706	1,94	1.102	501	1,37	492	224	0,61	1.357	617	1,69	1.126	512	1,40	0,04	10,69	1,19
Glass	2.791	1.269	3,48	1.408	640	1,75	2.931	1.332	3,65	3.154	1.434	3,93	2.571	1.169	3,20	0,09	24,40	2,71
Tin/Steel	910	414	1,13	325	148	0,40	838	381	1,04	846	385	1,05	730	332	0,91	0,03	6,92	0,77
Scrap Metal	692	315	0,86	6.706	3.048	8,35	10.320	4.691	12,85	6.729	3.059	8,38	6.112	2.778	7,61	0,22	57,99	6,45
Total	5.948	2.704	7	9.541	4.337	12	14.581	6.628	18	12.086	5.494	15	10.539	4.790	13,12	0,37	100	11,13
Absolute total	108.631	49.378	135	93.383	42.447	116	85.666	38.939	107	91.185	41.448	114	94.716	43.053	118	3,37		

Annex II: Computed waste data of McMurdo Station

Flammable Waste of the last four Seasons (years)	2009/2010		2010/2011		2011/2012		2012/2013		Average			Percentage	
	kgs	kgs/d	kgs	kgs/d	kgs	kgs/d	kgs	kgs/d	kgs	kgs/d	kgs/capita/d	kgs of group	kgs of total
Cardboard	103.080	282,41	93.650	256,58	137.680	377,21	70.140	192,16	101.138	277,09	0,58	20,11	20,11
Clothing and Rags	6.060	16,60	6.080	16,66	3.970	10,88	3.430	9,40	4.885	13,38	0,03	0,97	0,97
Cooking Oil/Lard	820	2,25	5.690	15,59	2.790	7,64	25.460	69,75	8.690	23,81	0,05	1,73	1,73
Mixed Paper	24.160	66,19	20430	55,97	41280	113,10	6.210	17,01	23.020	63,07	0,13	4,58	4,58
Plastics	13.360	36,60	13.490	36,96	30.080	82,41	28.870	79,10	21.450	58,77	0,12	4,26	4,26
Salvageable Materials	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0,00	0,00	0,00
Construction Debris	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0,00	0,00	0,00
Wastewater Treat. Biosolids	48.350	132,47	53.960	147,84	53.960	147,84	68.310	187,15	56.145	153,82	0,32	11,16	11,16
Food Waste & Containers	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0,00	0,00	0,00
Wood	336.420	921,70	346.180	948,44	151.110	414,00	317.010	868,52	287.680	788,16	1,64	57,19	57,19
Biomedical Waste	0		0		0		0						
Chemical Waste	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0,00	0,00	0,00
Total	532.250	1.458	539.480	1.478	420.870	1.153	519.430	1.423	503.008	1.378	2,88	100	100,00
Nonflammable and Recycable Waste of the last four Seasons (years)													
Total	0	0	0	0	0	0	0	0	0	0,00	0,00	0	0,00
Absolute total	532.250	1.458	539.480	1.478	420.870	1.153	519.430	1.423	503.008	1.378	2,88		

Annex III: 3D-picture of incinerator system from Deerberg Systems



Annex IV: Incinerator SEC 600 (Scanship Sustainable Solutions)

Page 1 of 1. August 1st 2010

SCANSHIP
Sustainable Solutions

TECHNICAL SPECIFICATION

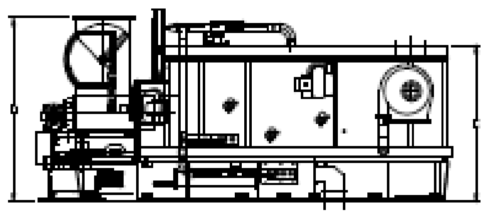
INCINERATOR SEC 600

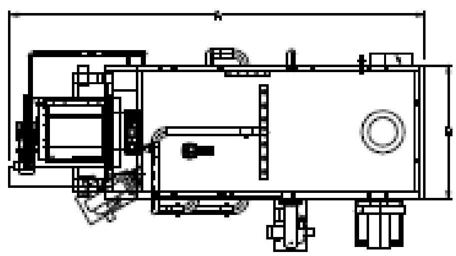
INCINERATOR

Type:	SEC-600
Thermal Capacity:	600 kW
Average Waste Capacity:	126 kg
Average Waste Calorific Value:	15 000 kJ/h
Temp. Primary zone:	700-1000°C
Temp. Secondary zone:	850-1000°C
Temp. Flue Gas	850-1000°C
Flue Gas Volume Incinerator:	1890 Nm3/h
Combustion Air Supply (max):	1000 Nm3/h
Cooling Air Supply (max):	1000 Nm3/h
Noise Level (max):	85 dB (A)
Heat Dissipation:	30 – 40 kW
Surface Temperature (above Ambient temperature)	15° C
Dust Emission at 11% O2 mg/Nm3	~ 50
Residence time of flue gas in Secondary Chamber	1.5 Sec
Flue Gas Duct dimension:	500 DN

The flue gas duct between Incinerator to have 100 mm mer insulation inside DN500 pipe (Yard Supply).

Outline Dimensions:	A: 5465 mm
	B: 1750 mm
	C: 2070 mm
	D: 2420 mm
Operating Weight:	15 000 kg





SCANSHIP CLEAN SHIP CONCEPT